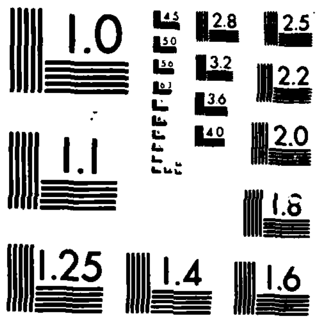
AD-A164 303 SEMICONDUCTING TRANSITION METAL SILICIDES FOR ELECTRO-OPTIC VSLI INTERCONNECTS(U) COLORADO RESEARCH DEVELOPMENT CORP FORT COLLINS J E MAHAN 15 OCT 85 1/1

UNCLASSIFIED N00014-85-C-0874 F/G 9/5 NL

END

FILMED

DTIC



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

DARPA Order #941

②

Interim Status Report No. 1

SEMICONDUCTING TRANSITION METAL SILICIDES for ELECTRO-OPTIC VSLI INTERCONNECTS

Prepared By

John E. Mahan, Ph.D.
Colorado Research Development Corporation
2629 Redwing Road, Suite 240
Fort Collins, Colorado 80526

for the

Office of Naval Research

Contract No. N00014-85-C-0874

October 15, 1985

Colorado Research Development Corporation

Drake Creekside Two Suite 250 2629 Redwing Fort Collins CO 80526 (303) 226-4131

PROGRESS REPORT #1

October 15, 1985

Since the start of the project on September 15, 1985, we have fabricated and partially characterized the $CrSi_2$ thin films, and made preparations for improved optical measurements and for investigating the two other proposed materials, $MnSi_{1.7}$ and $IrSi_{1.75}$. These steps are detailed below:

Chromium Silicide Formation

Thin films of chromium were deposited onto silicon substrates by ion beam sputtering. The substrates are either 1-0-0 orientation polished silicon wafers (p-type resistivity > 10 ohm-cm), similar wafers of the 1-1-1 orientation, or a third group of wafers which were first oxidized and then coated with ~5000A of polycrystalline silicon by low pressure chemical vapor deposition. The 1-1-1 wafers were used because of previous reports in the literature indicating an epitaxial growth tendency for $CrSi_2$ when grown on that substrate type. All the bare silicon wafers are for optical analysis and the polysilicon-coated ones are for resistivity measurements as an independent energy gap determination (the bare wafers are unsuitable for this as the substrate electrically shorts the film when no insulating oxide layer is present).

Before each chromium deposition the substrate was ion-milled in vacuo in order to achieve an atomically clean metal-silicon interface. Silicide layers were formed by reaction of the chromium films with their substrates in a quartz tube furnace with ultra-high purity argon flowing. 120-minute anneals were performed at temperatures ranging from 500 to 1100C in order to find the formation temperature giving $CrSi_2$ layers of the highest possible quality and

to provide a set of relatively defective samples for investigating defect absorption.

X-ray Diffraction Analysis of the Films

Powder diffraction-type patterns were obtained in order to identify the phases present in the films after reaction with the substrate. In all cases, the data indicate single-phase $CrSi_2$ layers.

A preferred orientation exists, as shown by the representative diffraction pattern in Figure 1 for a $CrSi_2$ film on 1-0-0 silicon. The peaks are labeled with the Miller indices of hexagonal $CrSi_2$. The <111> and <110> reflections are particularly enhanced in comparison to a random powder pattern. With the 1-1-1 substrate, the $CrSi_2$ <003> basal plane reflection is prominent, suggesting a tendency toward epitaxial growth with that substrate because of the symmetry match.

Characterization by Auger spectroscopy and electron microscopy is in progress.

Resistivity Measurements

A room temperature resistivity of 0.003 - 0.01 ohm-cm was obtained with a four-point probe using $CrSi_2$ films formed on polysilicon substrates. The resistivity as a function of annealing temperature for all the samples is shown in Figure 2. For the 1100C anneals a room temperature photoconductivity equal to about 1% of the dark conductivity was observed, using a standard 6V laboratory microscope illuminator. No photoconductivity was observed for lower annealing temperatures.

Optical Measurements

Work is in progress to improve the optical transmission and reflection facility that was used in our previous work on semiconducting $FeSi_2$. The

improvements include increasing the speed of the light chopper and isolating the DC power supply of the detector to obtain a higher signal-to-noise ratio, and adding infrared lenses to focus the monochromator output.

Preparations for $MnSi_{1.7}$ and $IrSi_{1.75}$

Manganese and iridium sputtering targets have been ordered from Varian Specialty Metals, Inc., and additional silicon wafers from Monsanto, Inc. The sputtering targets were promised for delivery 4-6 weeks after the order was placed in the latter part of September.

X-ray Diffraction Pattern

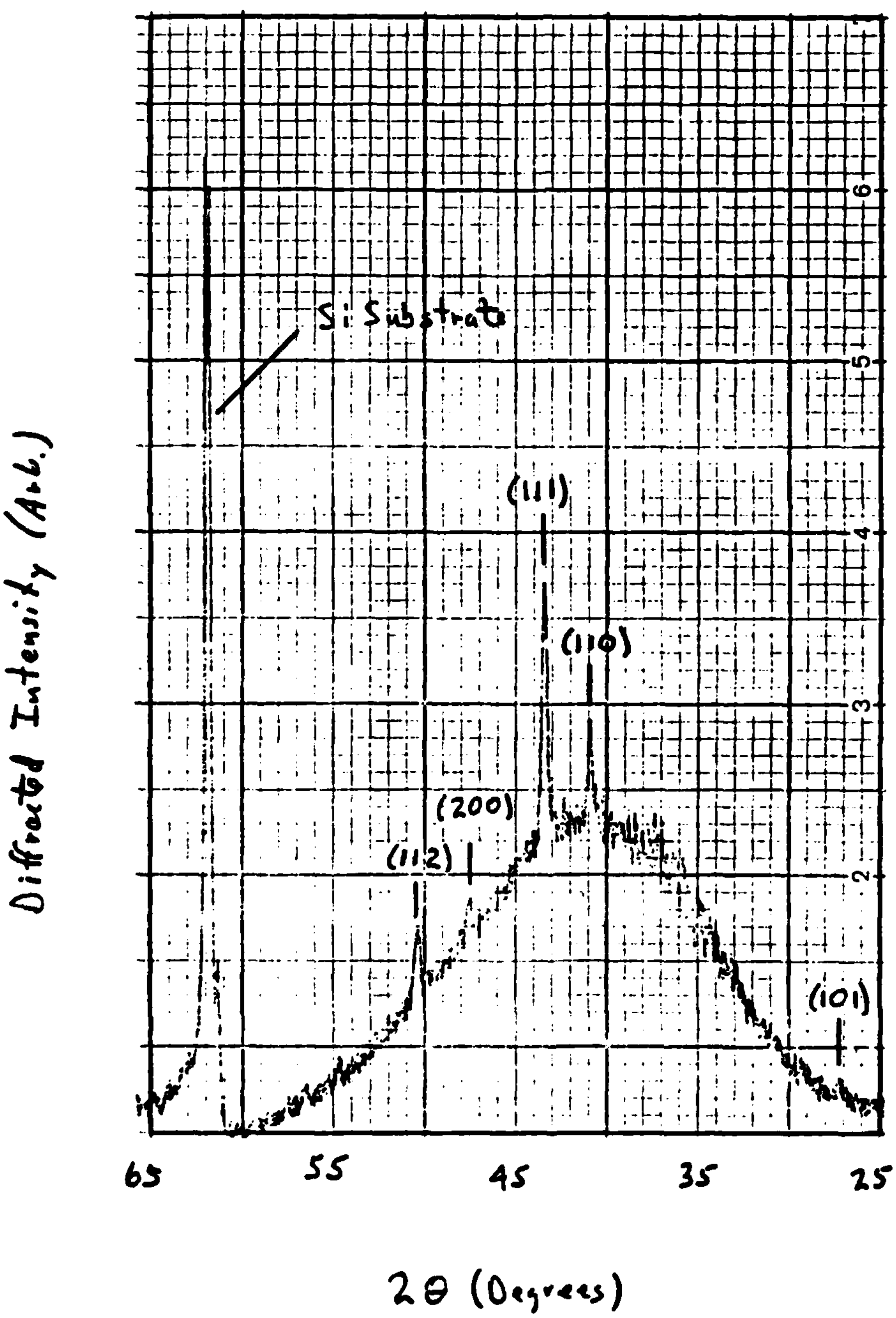


Figure 1

Room Temperature
Resistivity

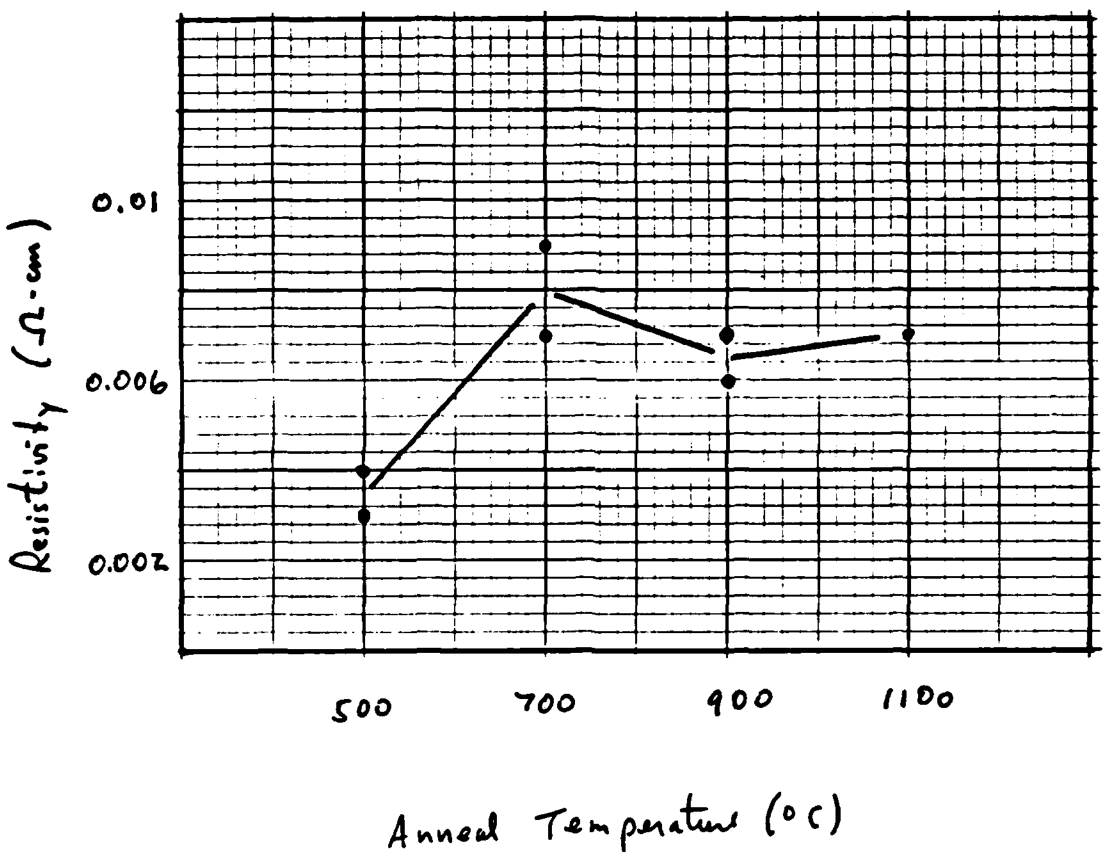


Figure 2

END

FILMED

3-86

DTIC